Missouri Department of Natural Resources

Biological Assessment Report

Little Osage River
Vernon County

October 2006 – March 2007

Prepared for:

Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Control Branch

Prepared by:

Missouri Department of Natural Resources
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Table of Contents

Tables

Figures

Attachments

1.0 Introduction

At the request of the Water Protection Program (**WPP**), the Environmental Services Program (**ESP**) Water Quality Monitoring Section (**WQMS**) conducted a biological assessment of Little Osage River. The Little Osage River flows through mostly rural portions of Bourbon County, Kansas and Vernon County, Missouri. A total of 22.3 miles of Little Osage River (see Figure 1) was added to the Missouri 303(d) list of impaired waters in 1998 due to low dissolved oxygen resulting from natural conditions. The total listed 22.3 stream miles is made up of 16 miles from Waterbody 3652 and 6.3 miles from Waterbody 1310.

This biological assessment was done to determine whether a biological impairment exists in a system that has been listed as impaired due to low dissolved oxygen. Little Drywood Creek (see Figure 1), a biological criteria reference stream, was also sampled to aid in differentiation of changes to the macroinvertebrate community that may have resulted from the extended drought and flood conditions during this time period in western Missouri.

Two null hypotheses are proposed:

1) Water chemistry will not differ from the Little Osage River sampling station and the Missouri Water Quality Standards.

2) The macroinvertebrate assemblage of Little Osage River sampling station will not differ from that found in biological criteria reference streams.

2.0 Study Area

The Little Osage River watershed originates in western Bourbon County, Kansas, near the town of Xenia and flows east to its confluence with the Marmaton River northeast of Horton, Missouri. At the sampling station the watershed is approximately 401 square miles, is mostly rural, and is dominated by grassland and crops. See Table 1 for a comparison of land use for the Plains/Osage Ecological Drainage Unit (**EDU**), the Little Osage River Hydrologic Unit (**HU**), and the Little Drywood Creek HU. The Little Osage River is located in the Central Plains/Osage/South Grand EDU (see Figure 1). An EDU is a region in which biological communities and habitat conditions can be expected to be similar.

Table 1
Percent Land Cover

	Urban	Crops	Grassland	Forest
Central Plains/Osage/South Grand EDU	3.0	28.0	44.0	14.0
Little Osage River (HU 14 - 10290103020001	0.0	28.0	50.0	11.0
Little Drywood #1 (HU 14 - 10290104060002	2.0	22.0	54.0	12.0

The Little Osage River sampling station was located in a reach of Waterbody 3652 that is designated class "C" with beneficial use designations of "livestock and wildlife watering" and "protection of warm water aquatic life and human health--fish consumption."

3.0 Site Descriptions

The Little Osage River sampling station was located close to the Kansas state line in Vernon County, Missouri. The sampling station for the Little Drywood Creek biological criteria reference stream was also located in Vernon County, Missouri. The coordinates for the sampling stations are given in Table 2 and a map of the Little Osage River sampling station is presented as Figure 2.

Table 2
Sample Station Locations

Stream-Station Number	Location-Section, Township, Range/ Latitude, Longitude	Description	County
Little Osage River #1	NE ¼ sec. 21, T. 37 N., R. 33 W. Lat. 37.980590 Long. -94.56274022	Downstream Hwy. V bridge, 0.5 miles north Stotesbury, MO.	Vernon
Little Drywood Creek #1	SE ¼ sec. 30, T. 35 N., R. 31 W. Lat. 37.785800 Long. -94.390080	Upstream bend in County Road (CR) 515E, Reference stream and SHAPP Control.	Vernon

4.0 Methods

Ken Lister and Brian Nodine conducted field sampling and other staff of the DNR, ESP, WQMS assisted in processing and analyses of data for this study. Sampling was conducted on October 10, 2006 and March 16, 2007 at Little Osage River and September 25, 2006 and April 4, 2007 at Little Drywood Creek. Fall sampling consisted of macroinvertebrate sampling, water quality sampling, and habitat assessments. Spring sampling consisted of macroinvertebrate and water quality sampling. In addition, a dissolved oxygen datalogger was deployed in Little Osage River for 3 days during summer 2006.

4.1 Physicochemical Data Collection and Analysis

4.1.1 *In situ* Water Quality Measurements

During each sampling period, *in situ* water quality measurements were collected at all stations. Field measurements included temperature (C°), dissolved oxygen (mg/L), conductivity (µS/cm), and pH.

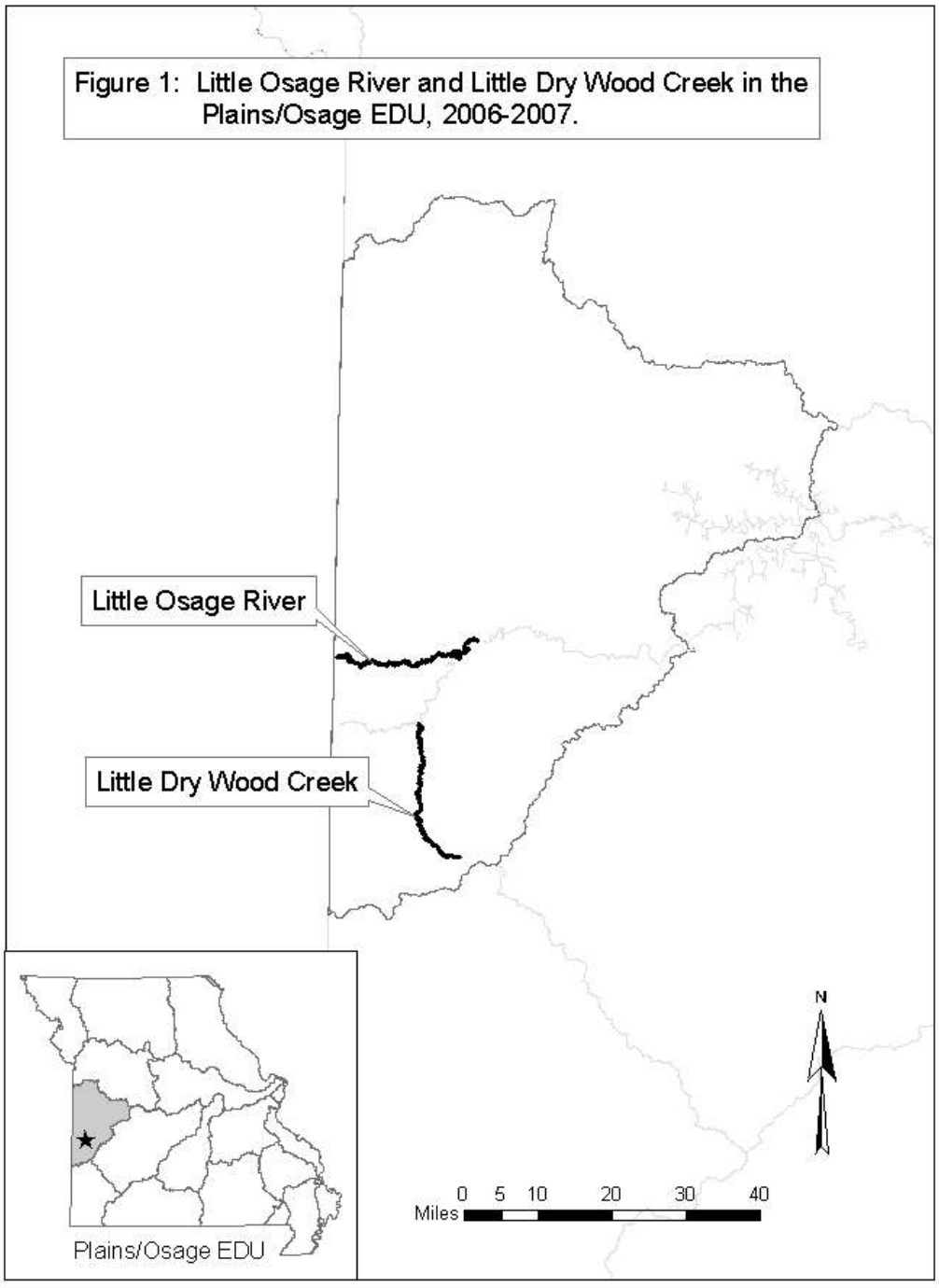


Figure 1: Little Osage River and Little Dry Wood Creek in the Plains/Osage EDU, 2006-2007.
Little Osage River
Little Dry Wood Creek
Plains/Osage EDU
N
0 5 10 20 30 40
Miles

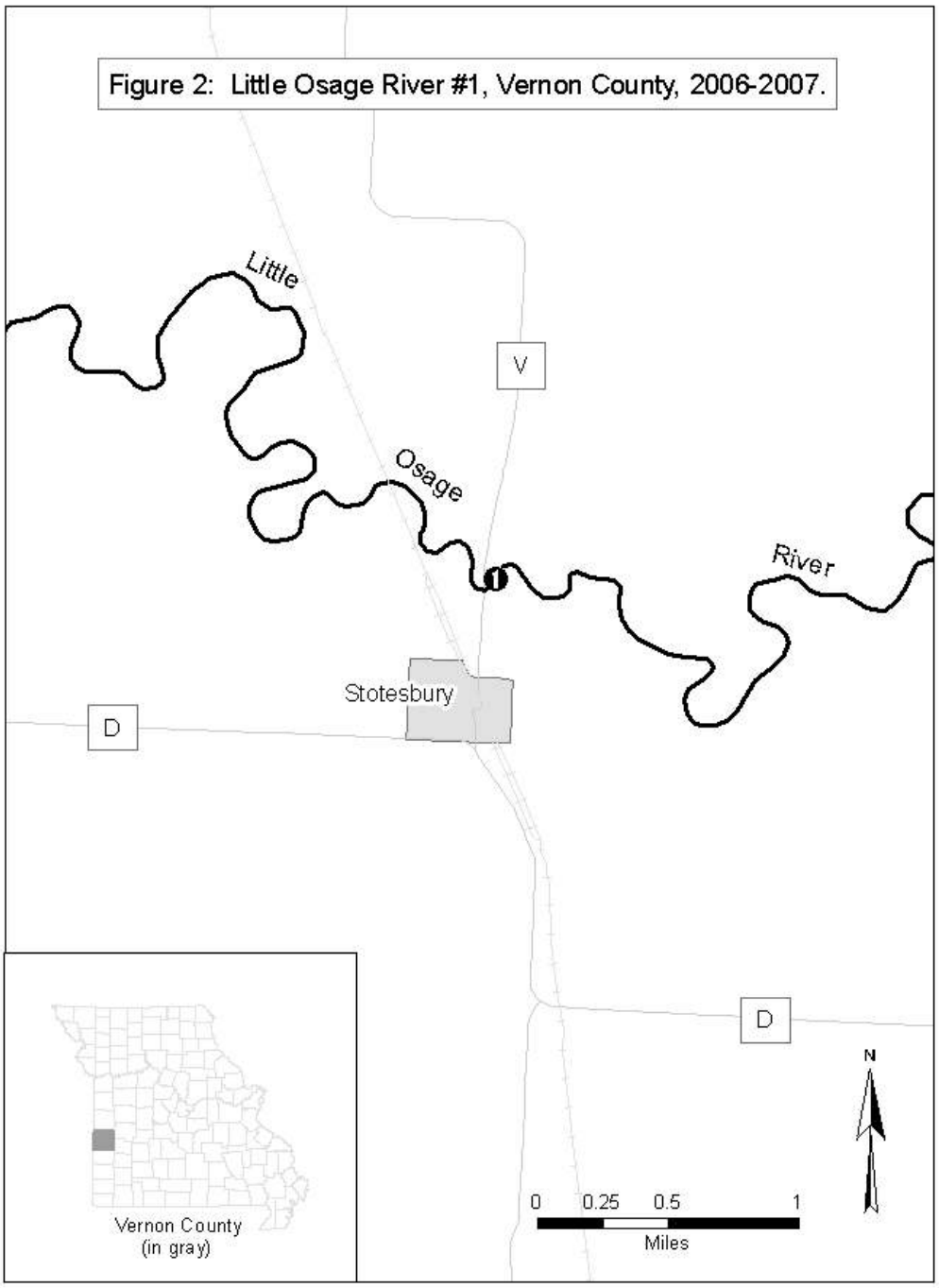


Figure 2: Little Osage River #1, Vernon County, 2006-2007.
Little
Osage
River
V
D
Stotesbury
D
N
0
0.25
0.5
1
Miles
Vernon County
(in gray)

4.1.2 Water Chemistry

Grab samples of stream water were collected and returned for analyses to ESP's Chemical Analysis Section. Samples were analyzed for turbidity, chloride, total phosphorus, ammonia-N, nitrate+nitrite-N, and total nitrogen. Procedures outlined in Field Sheet and Chain of Custody Record (MDNR 2001) and Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2003d) were followed when collecting water quality samples. Stream velocity was measured at each station during the survey period using a Marsh-McBirney Flo-Mate™ Model 2000. Discharge was calculated per the methods in the Standard Operating Procedure MDNR-FSS-113, Flow Measurement in Open Channels (MDNR 2003a).

4.1.3 Dissolved Oxygen Datalogger

An Aqua 2002 dissolved oxygen datalogger with Clark membrane electrode was deployed within the sampling reach at latitude 37.9805 and longitude -94.5627 in the Little Osage River from 10:45 a.m. on July 25, 2006 through 11 a.m. on July 28, 2006. The datalogger was programmed to measure and record dissolved oxygen and temperature data at 15-minute intervals. Side-by-side quality control measurements were collected with a YSI dissolved oxygen meter with Clark membrane electrode during deployment and retrieval.

4.2 Habitat Assessment

Stream habitat characteristics for each sampling station were measured during the fall 2006 sampling period using a standardized assessment procedure as described for glide/pool streams in the Stream Habitat Assessment Project Procedure (MDNR 2003c).

4.3 Macroinvertebrate Collection, Processing, and Analyses

A standardized macroinvertebrate sample collection procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2003b). The three standard habitats (depositional substrate in non-flowing water, large woody debris substrate, and rootmat substrate) for a glide/pool stream type were sampled at all locations.

A standardized sample processing and analysis procedure was followed as described in the SMSBPP. Once taxa were processed and identified, the following four metrics were calculated: 1) Taxa Richness (**TR**); 2) total number of taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**). These metrics are scored and combined to form a score for the Stream Condition Index (**SCI**). A Stream Condition Index between 20-16 qualifies as biologically supporting, between 14-10 as partially supporting, and between 8-4 as non-

supporting of aquatic life. The macroinvertebrate data are presented in Appendix A as laboratory bench sheets.

Data from Little Osage River were assessed based on biological criteria from reference streams within the perennial/wadeable watershed size classification. Biocriteria data collected from fall 2006, spring 2007, and previous survey years constituted the basis of the comparison. Glide/pool reference streams from adjacent EDUs (Little Drywood Creek in the Central Plains/Osage/South Grand EDU and East Fork Crooked River in the Central Plains/Blackwater/Lamine EDU) were combined for the purposes of calculating biological criteria SCI scores (MDNR 2002).

Three SMSBPP secondary metrics were also calculated to compare Little Osage River to Little Drywood Creek samples from fall 2006 and spring 2007. These metrics are community composition metrics and consist of the Quantitative Similarity Index for Taxa (**QSIT**), Percent Contribution of Dominant Taxon **(%DT**), and Dominants in Common (**DIC**).

4.4 Quality Assurance/Quality Control (QA/QC)

QA/QC procedures were followed as described in the SMSBPP and in accordance with the Fiscal Year 2007 Quality Assurance Project Plan for "Biological Assessment."

5.0 Data Results and Analyses

5.1 Physicochemical Data

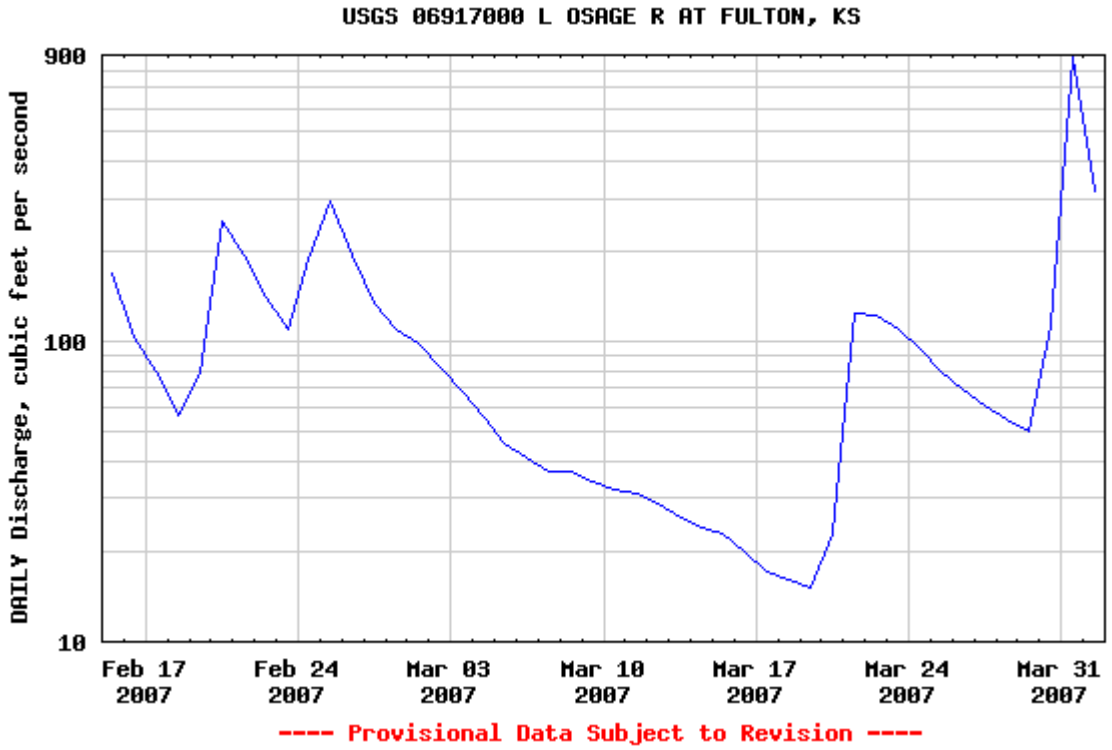
5.1.1 Stream Discharge

Little Osage River had no stream flow during the fall 2006 sampling event. Stream flow during the spring 2007 sampling event was 29.3 cubic feet per second (**cfs**). Steep banks and a deep channel made thorough macroinvertebrate sampling difficult in spring 2007. Since the stream was not wadeable at sampling time a canoe was used to reach the standard habitats. In addition, the Little Osage River had experienced several high flow discharge events of nearly 200-300 cfs in the month prior to the spring 2007 sampling event. These events may have scoured the channel and reduced the available macroinvertebrate community. Figure 3 is from the United States Geological Service (**USGS**) for the Little Osage River gauging station (06917000) at Fulton, Kansas, approximately 8 miles upstream from the sampling station. The discharge graph, from February 15, 2007 through March 15, 2007, documents high flows previous to sampling (Figure 3).

Little Drywood Creek had very little stream flow (0.01 cfs) during the fall 2006 sampling event. Little Drywood Creek does not have a USGS gauging station and direct comparisons of discharge cannot be made with Little Osage River for the time period

prior to the spring 2007 sampling event. However, the spring 2007 discrete discharge measurement made by ESP at Little Drywood Creek was 35.4 cfs and was greater than the measurement at Little Osage River. Since the two watersheds are in close proximity to each other it can be assumed that they experienced similar flow conditions in the period prior to spring 2007 sampling.

Figure 3



5.1.2 *In situ* Water Quality Measurements

In situ water quality measurements are summarized in Table 3 and Table 4. Temperature readings varied seasonally, with temperatures higher in the fall than in the spring. Values for pH were fairly consistent within and between seasons. Conductivity readings were higher during the fall sampling season. Dissolved oxygen concentrations were lower during the fall season. The Little Osage River dissolved oxygen level was below the 5 mg/L minimum criteria listed in the Missouri Water Quality Standards for protection of aquatic life (warm-water and cool-water fisheries). Dissolved oxygen concentrations were higher during the spring season with levels above the minimum criteria.

Table 3
Fall 2006 *In situ* Little Osage River and Little Drywood Creek Discrete Water Quality Measurements

Station & (Sample #)	Date	Temp (C°)	Dissolved O_2 (mg/L)	Conductivity (µS/cm)	pH	Discharge (cfs)
Little Osage River (0607292)	10/3/2006	19.0	**2.78**	527	7.7	0
Little Drywood Creek (0603214)	9/25/2006	17.0	6.42	456	7.8	0.1

Table 4
Spring 2007 *In situ* Little Osage River and Little Drywood Creek Discrete Water Quality Measurements

Station & (Sample #)	Date	Temp (C°)	Dissolved O_2 (mg/L)	Conductivity (µS/cm)	pH	Discharge (cfs)
Little Osage River (0704021)	3/16/2007	11.5	6.8	432	7.5	29.3
Little Drywood Creek (0704054)	4/4/2007	13.5	8.04	306	7.8	35.4

5.1.3 Water Chemistry

Water chemistry results are presented in Table 5 (fall 2006) and Table 6 (spring 2007). During the fall 2006 season nutrient concentrations were consistent between streams but Little Drywood Creek had higher chloride levels. Ammonia as nitrogen (NH_3-N) was not detected at any sites during either sample season. Concentrations of NO_2+NO_3-N and total nitrogen were higher at Little Drywood Creek in the spring 2007 samples.

Table 5
Fall 2006 Little Osage River and Little Drywood Creek Water Chemistry Results

Station & (Sample #)	NH_3-N	NO_2+NO_3-N	Total Nitrogen	Total Phosphorus	Chloride	Turbidity
Little Osage River (607292)	0.03*	0.02**	0.49	0.07	8.99	9.21
Little Drywood Creek (603214)	0.03*	0.02**	0.56	0.03**	**51.2**	4.84

*Below detectable levels ** Estimated value – below Probable Quantitative Limits

Table 6
Spring 2007 Little Osage River and Little Drywood Creek Water Chemistry Results

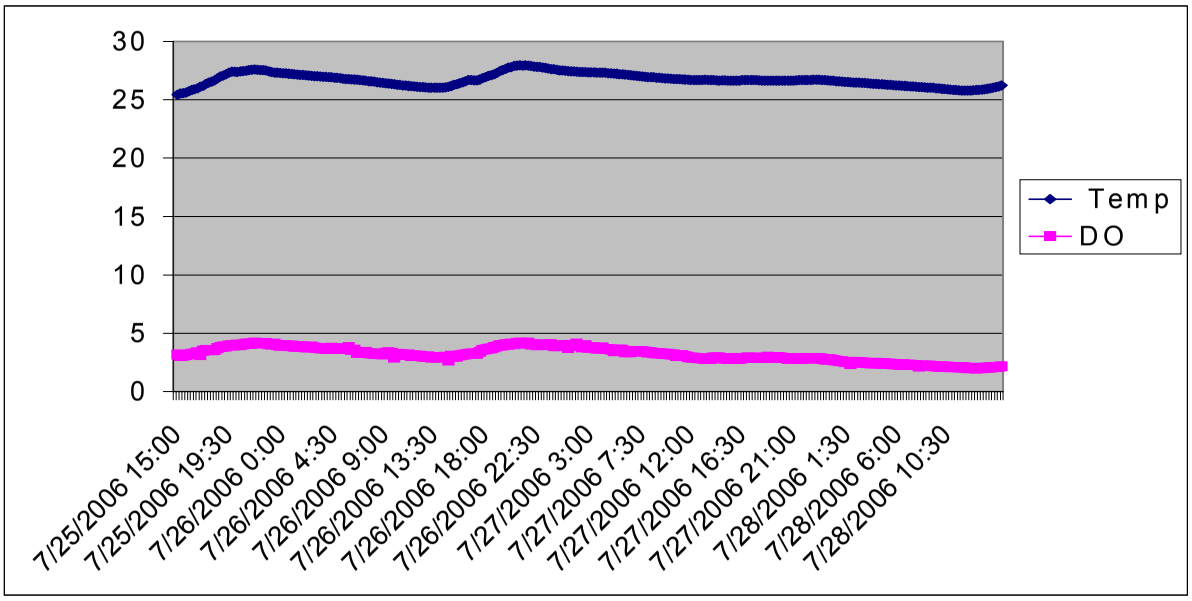
Station & (Sample #)	NH_3-N	NO_2+NO_3-N	Total Nitrogen	Total Phosphorus	Chloride	Turbidity
Little Osage River (704021)	0.03*	0.01*	0.43	0.06	13.0	4.9
Little Drywood Creek (704054)	0.03*	**0.41**	**1.12**	0.09	13.0	11.4

*Below detectable levels

5.1.4 Dissolved Oxygen Datalogger

Raw data from the Aqua 2002 datalogger and quality control data collected with a YSI Dissolved Oxygen Meter are attached as Appendix B. Quality control readings were taken with several dataloggers submerged as a group (control) before and after deployment. In addition, quality control readings were taken at deployment and retrieval in the test stream. Quality control data from datalogger deployment and retrieval times should be within 0.5 mg/L of the YSI meter for the continuous data to be considered valid. The datalogger data meets quality control requirements. Dissolved Oxygen Data is presented in graphic form in Figure 4. During the deployment period all values were below the 5.0 mg/L statewide criteria for designated use of Protection of Aquatic Life for warm water streams.

Figure 4
Little Osage River July 2006
Dissolved Oxygen Datalogger (DO = mg/L; Temp = C°)



5.2 Habitat Assessment

Habitat assessment scores were recorded for the Little Osage River sampling station and a biocriteria reference stream, Little Drywood Creek. Results are presented in Table 7. According to the project procedure, a study site is considered to be fully supportive of the biological community if the total score from the physical habitat assessment is 75% to 100% similar to the total score of a reference site. The habitat score for Little Drywood Creek was 132 and the habitat score for the Little Osage River sampling station was 127. Because the Little Osage River station had a habitat score that exceeded the required range of similarity (96%), it was inferred that the sites should support comparable biological communities.

Table 7
Stream Habitat Assessment Scores and Percent Comparison for Little Osage River #1 and Little Drywood Creek #1 (SHAPP Control), (October 2006)

	Little Osage River #1	Little Drywood Creek #1
SHAPP Score	127	132
Percent of SHAPP Control	96	--

5.3 Biological Assessment

5.3.1 Biological Criteria Metrics for the Stream Condition Index

Metrics calculated from reference streams and a scoring system provide the criteria for calculating a Stream Condition Index (**SCI**). The Central Plains/Osage/South Grand EDU scoring criteria for fall and spring sample seasons are presented in Tables 8 and 9.

Table 8
Biological Criteria for Warm Water Reference Streams in the Central Plains/Osage/South Grand EDU, Fall Season

	Score = 5	Score = 3	Score = 1
TR	>55	55-28	<28
EPTT	>6	6-3	<3
BI	<7.73	7.73-8.86	>8.86
SDI	>2.84	2.84-1.42	<1.42

Table 9
Biological Criteria for Warm Water Reference Streams in the Central Plains/Osage/South Grand EDU, Spring Season

	Score = 5	Score = 3	Score = 1
TR	>50	50-25	<25
EPTT	>8	8-4	<4
BI	<7.16	7.16-8.58	>8.58
SDI	>2.29	2.29-1.14	<1.14

5.3.2 Stream Condition Index Scores

Metrics calculated for the Little Osage River and Little Drywood Creek were compared to biological criteria scoring information from the Central Plains/Osage/South Grand EDU. SCI scores for fall 2006 are provided in Table 10 and spring 2007 in Table 11. All scores except Little Osage River spring 2007 are considered fully supporting.

Table 10
Little Osage River and Little Drywood Creek Metric Values and Scores
Fall 2006

Site	TR	EPTT	BI	SDI	SCI	Support
Little Osage River - metric	66	11	7.28	3.32		
Little Osage River - score	5	5	5	5	20	Full
Little Drywood Creek - metric	58	7	8.22	2.97		
Little Drywood Creek - score	5	5	3	5	18	Full

Table 11
Little Osage River and Little Drywood Creek Metric Values and Scores
Spring 2007

Site	TR	EPTT	BI	SDI	SCI	Support
Little Osage River - metric	51	1	8.60	1.76		
Little Osage River - score	5	1	1	3	10	**Partial**
Little Drywood Creek - metric	55	6	7.92	2.60		
Little Drywood Creek - score	5	3	3	5	16	Full

5.3.3 Macroinvertebrate Community Composition

Table 12 and Table 13 provide community composition data for the QSIT, %DT, and the DIC metrics at each sampling station. The percent relative abundance data were averaged from the sum of three macroinvertebrate habitats--nonflow, large woody debris, and rootmat--sampled at each station.

The QSIT is 38.3% for fall 2006 and lower at 24.5% for spring 2007, documenting less similarity between stream communities in the spring. The %DT is higher in spring 2007 for both streams and also has more difference between streams. The dominant taxon comprises over half of the abundance at Little Osage River in spring 2007. The DIC is 0/5 in fall 2006 and 2/5 in spring 2007.

Table 12
Fall 2006 Little Osage River and Little Drywood Creek Macroinvertebrate Composition

QSIT = 38.3%	Little Osage River	Little Drywood Creek
% Dominant Taxon	Dicrotendipes = 15.1%	Glyptotendipes = 21.6%
Dominants in Common		
	Dicrotendipes = 15.1%	
	Dubiraphia = 13.7%	
	Tribelos = 8.2%	
	Ceratopogoninae = 4.0%	
	Argia = 4.0%	
		Glyptotendipes = 21.6%
		Tubificidae = 11.4%
		Procladius = 9.8%
		Stenacron = 8.9%
		Acarina = 6.3%

Table 13
Spring 2007 Little Osage River and Little Drywood Creek Macroinvertebrate Composition

QSIT = 24.5%	Little Osage River	Little Drywood Creek
% Dominant Taxon	Hydrobaenus = **58.3%**	Lirceus = 35.6%
Dominants in Common		
	Hydrobaenus = 58.3%	
X	Cricotopus/Orthocladius = 16.2%	Cricotopus/Orthocladius = 9.1%
X	Tubificidae = 5.2%	Tubificidae = 8.0%
	Ilyodrilus templetoni = 2.5%	
	Paratendipes = 1.9%	
		Lirceus = 35.6%
		Physella = 11.3%
		Neoporus = 3.6%

Two of the secondary metrics (QSIT & %DT) supports that there is more difference between Little Osage River and Little Drywood Creek communities in spring 2007. The community composition metrics provide additional verification for the lower spring 2007 SCI scores for Little Osage River.

6.0 Discussion

There was little difference in water chemistry values between Little Osage River and Little Drywood Creek. Any values that were higher were found in the reference stream, Little Drywood Creek. The higher spring 2007 nitrogen levels (nitrate+nitrite-N & total N) in Little Drywood Creek were most likely related to the rainfall and higher discharge in the time period immediately before sampling.

Dissolved oxygen measurements were below the 5 mg/L minimum criteria at Little Osage River during the summer (July) and fall (October). Although dissolved oxygen measurements were not collected continuously from July through October it is assumed that there was a significant portion of this time period in which the value was below 5 mg/L. It is likely that the low flows observed during the summer and fall seasons significantly contributed to stagnant and hypoxic conditions in Little Osage River. There are no dissolved oxygen datalogger values in this study from Little Drywood Creek and only one discrete value from the fall. The fall value is well above the criteria of 5 mg/L. It is unlikely that the time of day had a significant effect on the difference in fall dissolved oxygen values between Little Osage River and Little Drywood Creek since the measurements were collected well into the daylight hours (11:30 a.m. and 2:30 p.m., respectively). Cooler water, which has a higher affinity for dissolved oxygen, coupled with higher stream discharge contributed to the higher dissolved oxygen concentrations observed in spring.

The Little Osage River sample stations had a habitat score that was 96% of the biological criteria reference stream Little Drywood Creek. Since habitat is equivalent between streams it should not be a major factor in differences between macroinvertebrate communities.

Little Osage River metric and SCI scores were most similar to the biological criteria in fall 2006. This comparison is noteworthy because Little Osage River samples were collected during the same time period as Little Drywood Creek, the result being that the respective macroinvertebrate communities would have been exposed to similar conditions (e.g. flow, temperature, dissolved oxygen) in the months preceding the sample season. Temperature and dissolved oxygen datalogger information is available for at least three locations in Little Drywood Creek for the same summer 2006 time period as datalogger information for Little Osage River (MEC Water Resources, Columbia, MO). The MEC datalogger for the July 25-27 time period that was closest to the Little Drywood Creek sampling station had a watershed area of 68.7 square miles. This Little

Drywood Creek dissolved oxygen monitoring station (LDC3) was like Little Osage River in that it had no dissolved oxygen values over 5.0 mg/L.

The Little Osage River macroinvertebrate metric and SCI scores collected in spring 2007 were very different from biological criteria. A given aquatic community can be variable due to natural causes, but the spring 2007 variation between Little Osage River and the criteria is significant. There is little water or habitat quality data to help explain the change in status for Little Osage River in spring 2007. There is some data to suggest that scouring high water, increased discharge at the time of sampling, and the large, deep channel at Little Osage River had a negative impact on the SCI score, possibly because of ineffective sampling.

7.0 Conclusions

The dissolved oxygen levels at Little Osage River were below the 5-mg/L criteria during a significant amount of the summer low flow season. The null hypothesis that water chemistry will not differ from the Little Osage River sampling station and the Missouri Water Quality Standards is rejected.

There were two macroinvertebrate samples from Little Osage River. The SCI scores were fully supporting in one season (fall) and partially supporting in the other season (spring). Two widely differing SCI scores are inconclusive concerning the support status for the protection of aquatic life in warm water glide/pool streams. However, an SCI score of 10 is substantially different than a minimal fully supporting score of 16 and the null hypothesis stating that the macroinvertebrate assemblage of Little Osage River sampling station will not differ from that found in biological criteria reference streams is rejected.

8.0 Recommendations

1) Deploy dissolved oxygen dataloggers at multiple locations on Little Osage River during July, August, September, and early October.

2) Conduct fall and spring macroinvertebrate stream assessments at multiple locations within the 303(d) listed segment.

9.0 References Cited

Missouri Department of Natural Resources. 2001. Field Sheet and Chain of Custody Record. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 8 pp.

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Appendix A

Little Osage River Macroinvertebrate Taxa Lists

Aquatic Invertebrate Database Bench Sheet Report
October 3, 2006 - Little Osage R [0602744], Station #1

ORDER (Taxa)	NF	SG	RM
"HYDRACARINA"			
Acarina	4	2	17
AMPHIPODA			
Hyalella azteca		5	7
Crangonyx			14
COLEOPTERA			
Tropisternus			1
Scirtidae			25
Dubiraphia	64	2	49
Stenelmis	7	2	1
DECAPODA			
Palaemonetes kadiakensis		3	7
Orconectes luteus			-99
Orconectes virilis			-99
DIPTERA			
Culex			1
Chaoborus	33		
Ceratopogoninae	30	4	
Ablabesmyia	1		14
Procladius	13	5	
Parakiefferiella		10	4
Chironomus	5	4	
Cryptochironomus	1	1	
Dicrotendipes	8	106	13
Glyptotendipes			1
Kiefferulus	2	2	1
Paratendipes	2		
Parachironomus			5
Polypedilum halterale grp		1	
Polypedilum fallax grp		1	
Saetheria	3		
Polypedilum scalaenum grp		2	
Tribelos		67	2
Pseudochironomus		12	
Cladotanytarsus	1	3	
Paratanytarsus			1
Tanytarsus		9	4
Tanypus	11	2	
Thienemannimyia grp.	1	2	1
Natarsia	2		
Labrundinia		1	4
EPHEMEROPTERA			
Callibaetis		10	
Procloeon	1	5	
Heptageniidae	1		
Stenacron		9	3
Caenis latipennis			3
Leptophlebiidae		1	13

ORDER (Taxa)	NF	SG	RM
Hexagenia limbata		1	
HEMIPTERA			
Rheumatobates			1
Neoplea			2
Corixidae	7	6	
Mesovelia			1
LIMNOPHILA			
Physella			3
Menetus	1		20
Ancylidae			3
MEGALOPTERA			
Sialis	1	-99	
ODONATA			
Argia		6	28
Basiaeschna janata			-99
Macromia			2
Perithemis			-99
TRICHOPTERA			
Cyrnellus fraternus	1		
Hydroptila			1
Triaenodes			1
Oecetis			3
TUBIFICIDA			
Tubificidae	18	8	1
Branchiura sowerbyi	19		
Aulodrilus	1	18	
Ilyodrilus templetoni	16	2	
Quistradrilus multisetosus	9	2	
VENEROIDEA			
Sphaeriidae	1		
Corbicula	6		

Aquatic Invertebrate Database Bench Sheet Report
March 16, 2007 - Little Osage R [0703221], Station #1

ORDER (Taxa)	NF	SG	RM
"HYDRACARINA"			
Acarina	4		
AMPHIPODA			
Hyalella azteca		1	12
Crangonyx			4
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
COLEOPTERA			
Uvarus			1
Neoporus			1
Tropisternus			-99
Scirtidae	2	3	3
Dubiraphia	4	2	9
DECAPODA			
Palaemonetes kadiakensis	-99		-99
Orconectes virilis			-99
DIPTERA			
Gonomyia	2		
Ormosia	1		
Chaoborus	1		
Pericoma	1		
Ceratopogoninae	7	1	
Cnephia	1	2	6
Procladius	6	1	2
Cricotopus/Orthocladius	5	71	90
Parakiefferiella		2	
Parametriocnemus	5		1
Paraphaenocladius	4		
Smittia	5		
Hydrobaenus	124	252	222
Dicrotendipes	2	5	
Kiefferulus	1		
Paratendipes	20		
Stenochironomus		1	
Tribelos		1	
Tanytarsus	2		
Chrysops	1		
Tabanus			-99
Zavreliella	1		
Tanypus	4		
Diptera	1	1	
ISOPODA			
Lirceus			1
LIMNOPHILA			
Physella	3		
Menetus	1		
Ancylidae	5		
ODONATA			

ORDER (Taxa)	NF	SG	RM
Nasiaeschna pentacantha			-99
RHYNCHOBDELLIDA			
Glossiphoniidae			-99
TRICHOPTERA			
Ironoquia			1
TUBIFICIDA			
Tubificidae	51		2
Branchiura sowerbyi	13		
Aulodrilus	6		
Ilyodrilus templetoni	25	1	
Limnodrilus hoffmeisteri	5		3
Limnodrilus claparedianus	1		
Quistradrilus multisetosus	5		
Enchytraeidae	5		
VENEROIDEA			
Sphaeriidae	3		-99

Appendix B

Dissolved Oxygen Datalogger Values

AQUA 2002 Data Report
****

Start time [Day] : 7/25/2006 08:00
Down load time [Day] : 7/30/2006 16:28
Sample interval [Minute(s)] : 00:15
Battery status at down load : OK
Samples collected : 514
****

Notes:
****

Logger #107
PP# 100465

****

Time	Temp - C°	DO - mg/L	QC - mg/L
7/25/2006 9:15	23.86	2.38	Control 2.18
7/25/2006 9:30	24.07	5.44	Out of water
7/25/2006 9:45	27.01	7.01	Out of water
7/25/2006 10:00	29.22	6.99	Out of water
7/25/2006 10:15	30.82	7.19	Out of water
7/25/2006 10:30	32.56	6.65	Out of water
7/25/2006 10:45	25.45	3.17	Deploy 2.67
7/25/2006 11:00	25.53	3.06	
7/25/2006 11:15	25.57	3.08	
7/25/2006 11:30	25.62	3.13	
7/25/2006 11:45	25.73	3.18	
7/25/2006 12:00	25.85	3.23	
7/25/2006 12:15	25.91	3.26	
7/25/2006 12:30	26	3.37	
7/25/2006 12:45	26.11	3.12	
7/25/2006 13:00	26.2	3.5	
7/25/2006 13:15	26.36	3.57	
7/25/2006 13:30	26.48	3.57	
7/25/2006 13:45	26.56	3.55	
7/25/2006 14:00	26.66	3.57	
7/25/2006 14:15	26.83	3.7	
7/25/2006 14:30	26.99	3.81	
7/25/2006 14:45	27.09	3.85	
7/25/2006 15:00	27.2	3.86	
7/25/2006 15:15	27.31	3.93	
7/25/2006 15:30	27.4	3.98	
7/25/2006 15:45	27.4	3.94	
7/25/2006 16:00	27.39	4	
7/25/2006 16:15	27.42	3.98	
7/25/2006 16:30	27.45	4.05	
7/25/2006 16:45	27.48	4.09	
7/25/2006 17:00	27.55	4.12	
7/25/2006 17:15	27.58	4.09	
7/25/2006 17:30	27.6	4.18	
7/25/2006 17:45	27.58	4.15	
7/25/2006 18:00	27.55	4.14	
7/25/2006 18:15	27.54	4.14	
7/25/2006 18:30	27.51	4.15	
7/25/2006 18:45	27.43	4.06	
7/25/2006 19:00	27.38	4.05	
7/25/2006 19:15	27.34	4.1	
7/25/2006 19:30	27.33	3.99	
7/25/2006 19:45	27.3	3.92	
7/25/2006 20:00	27.27	3.94	
7/25/2006 20:15	27.26	3.93	
7/25/2006 20:30	27.23	3.91	
7/25/2006 20:45	27.21	3.94	
7/25/2006 21:00	27.19	3.85	
7/25/2006 21:15	27.15	3.85	

7/25/2006 21:30	27.13	3.88
7/25/2006 21:45	27.12	3.85
7/25/2006 22:00	27.11	3.79
7/25/2006 22:15	27.08	3.78
7/25/2006 22:30	27.06	3.87
7/25/2006 22:45	27.03	3.78
7/25/2006 23:00	27.01	3.72
7/25/2006 23:15	26.99	3.71
7/25/2006 23:30	26.97	3.71
7/25/2006 23:45	26.96	3.65
7/26/2006 0:00	26.93	3.67
7/26/2006 0:15	26.92	3.74
7/26/2006 0:30	26.89	3.63
7/26/2006 0:45	26.87	3.69
7/26/2006 1:00	26.85	3.67
7/26/2006 1:15	26.81	3.67
7/26/2006 1:30	26.79	3.65
7/26/2006 1:45	26.76	3.81
7/26/2006 2:00	26.75	3.56
7/26/2006 2:15	26.73	3.59
7/26/2006 2:30	26.71	3.32
7/26/2006 2:45	26.69	3.33
7/26/2006 3:00	26.66	3.32
7/26/2006 3:15	26.64	3.39
7/26/2006 3:30	26.6	3.28
7/26/2006 3:45	26.57	3.27
7/26/2006 4:00	26.55	3.24
7/26/2006 4:15	26.51	3.24
7/26/2006 4:30	26.49	3.22
7/26/2006 4:45	26.45	3.18
7/26/2006 5:00	26.42	3.3
7/26/2006 5:15	26.4	3.36
7/26/2006 5:30	26.37	3.32
7/26/2006 5:45	26.33	2.9
7/26/2006 6:00	26.3	3.21
7/26/2006 6:15	26.27	3.2
7/26/2006 6:30	26.24	3.16
7/26/2006 6:45	26.22	3.12
7/26/2006 7:00	26.19	3.16
7/26/2006 7:15	26.17	3.05
7/26/2006 7:30	26.15	3.09
7/26/2006 7:45	26.12	3.07
7/26/2006 8:00	26.1	3.05
7/26/2006 8:15	26.08	2.99
7/26/2006 8:30	26.07	2.96
7/26/2006 8:45	26.05	3
7/26/2006 9:00	26.04	2.9
7/26/2006 9:15	26.02	2.93
7/26/2006 9:30	26.02	2.94
7/26/2006 9:45	26.02	2.91
7/26/2006 10:00	26.04	2.95
7/26/2006 10:15	26.07	2.96

7/26/2006 10:30	26.12	2.65
7/26/2006 10:45	26.19	3.06
7/26/2006 11:00	26.28	3
7/26/2006 11:15	26.34	3.01
7/26/2006 11:30	26.41	3.09
7/26/2006 11:45	26.51	3.14
7/26/2006 12:00	26.58	3.18
7/26/2006 12:15	26.7	3.24
7/26/2006 12:30	26.7	3.26
7/26/2006 12:45	26.67	3.27
7/26/2006 13:00	26.67	3.23
7/26/2006 13:15	26.74	3.39
7/26/2006 13:30	26.85	3.57
7/26/2006 13:45	26.94	3.62
7/26/2006 14:00	27.06	3.68
7/26/2006 14:15	27.1	3.69
7/26/2006 14:30	27.2	3.79
7/26/2006 14:45	27.3	3.86
7/26/2006 15:00	27.45	3.95
7/26/2006 15:15	27.55	3.96
7/26/2006 15:30	27.66	4.04
7/26/2006 15:45	27.75	4.01
7/26/2006 16:00	27.8	4.11
7/26/2006 16:15	27.89	4.07
7/26/2006 16:30	27.93	4.15
7/26/2006 16:45	27.95	4.19
7/26/2006 17:00	27.94	4.12
7/26/2006 17:15	27.95	4.13
7/26/2006 17:30	27.94	4.18
7/26/2006 17:45	27.89	4.04
7/26/2006 18:00	27.85	4.06
7/26/2006 18:15	27.83	3.97
7/26/2006 18:30	27.81	3.98
7/26/2006 18:45	27.76	4.02
7/26/2006 19:00	27.73	4.03
7/26/2006 19:15	27.69	4.01
7/26/2006 19:30	27.63	4.04
7/26/2006 19:45	27.61	3.91
7/26/2006 20:00	27.57	3.91
7/26/2006 20:15	27.53	3.9
7/26/2006 20:30	27.51	3.93
7/26/2006 20:45	27.49	3.96
7/26/2006 21:00	27.46	3.72
7/26/2006 21:15	27.43	3.99
7/26/2006 21:30	27.42	3.94
7/26/2006 21:45	27.4	4.12
7/26/2006 22:00	27.39	3.92
7/26/2006 22:15	27.38	3.78
7/26/2006 22:30	27.37	3.97
7/26/2006 22:45	27.36	3.76
7/26/2006 23:00	27.36	3.79
7/26/2006 23:15	27.35	3.76

7/26/2006 23:30	27.34	3.68
7/26/2006 23:45	27.34	3.7
7/27/2006 0:00	27.32	3.76
7/27/2006 0:15	27.31	3.64
7/27/2006 0:30	27.28	3.64
7/27/2006 0:45	27.26	3.6
7/27/2006 1:00	27.25	3.46
7/27/2006 1:15	27.23	3.47
7/27/2006 1:30	27.2	3.58
7/27/2006 1:45	27.18	3.59
7/27/2006 2:00	27.16	3.37
7/27/2006 2:15	27.14	3.37
7/27/2006 2:30	27.11	3.37
7/27/2006 2:45	27.08	3.47
7/27/2006 3:00	27.05	3.44
7/27/2006 3:15	27.02	3.45
7/27/2006 3:30	26.99	3.45
7/27/2006 3:45	26.96	3.41
7/27/2006 4:00	26.95	3.36
7/27/2006 4:15	26.94	3.37
7/27/2006 4:30	26.92	3.31
7/27/2006 4:45	26.89	3.27
7/27/2006 5:00	26.87	3.28
7/27/2006 5:15	26.85	3.25
7/27/2006 5:30	26.84	3.21
7/27/2006 5:45	26.82	3.24
7/27/2006 6:00	26.8	3.17
7/27/2006 6:15	26.79	3.16
7/27/2006 6:30	26.78	3.06
7/27/2006 6:45	26.76	3.07
7/27/2006 7:00	26.75	3.12
7/27/2006 7:15	26.73	3.04
7/27/2006 7:30	26.71	2.97
7/27/2006 7:45	26.7	2.9
7/27/2006 8:00	26.69	2.89
7/27/2006 8:15	26.68	2.88
7/27/2006 8:30	26.68	2.85
7/27/2006 8:45	26.7	2.86
7/27/2006 9:00	26.71	2.8
7/27/2006 9:15	26.7	2.79
7/27/2006 9:30	26.68	2.79
7/27/2006 9:45	26.68	2.92
7/27/2006 10:00	26.67	2.89
7/27/2006 10:15	26.65	2.92
7/27/2006 10:30	26.66	2.85
7/27/2006 10:45	26.66	2.82
7/27/2006 11:00	26.65	2.79
7/27/2006 11:15	26.63	2.85
7/27/2006 11:30	26.62	2.86
7/27/2006 11:45	26.62	2.8
7/27/2006 12:00	26.63	2.81
7/27/2006 12:15	26.68	2.86

7/27/2006 12:30	26.69	2.88
7/27/2006 12:45	26.69	2.91
7/27/2006 13:00	26.69	2.87
7/27/2006 13:15	26.69	2.88
7/27/2006 13:30	26.68	2.9
7/27/2006 13:45	26.66	2.9
7/27/2006 14:00	26.64	2.88
7/27/2006 14:15	26.64	2.87
7/27/2006 14:30	26.64	2.96
7/27/2006 14:45	26.65	2.9
7/27/2006 15:00	26.64	2.91
7/27/2006 15:15	26.64	2.94
7/27/2006 15:30	26.65	2.94
7/27/2006 15:45	26.65	2.89
7/27/2006 16:00	26.64	2.88
7/27/2006 16:15	26.64	2.79
7/27/2006 16:30	26.64	2.84
7/27/2006 16:45	26.65	2.84
7/27/2006 17:00	26.67	2.79
7/27/2006 17:15	26.68	2.87
7/27/2006 17:30	26.69	2.81
7/27/2006 17:45	26.69	2.84
7/27/2006 18:00	26.69	2.85
7/27/2006 18:15	26.69	2.84
7/27/2006 18:30	26.71	2.85
7/27/2006 18:45	26.72	2.85
7/27/2006 19:00	26.71	2.86
7/27/2006 19:15	26.7	2.8
7/27/2006 19:30	26.68	2.73
7/27/2006 19:45	26.66	2.75
7/27/2006 20:00	26.64	2.77
7/27/2006 20:15	26.62	2.7
7/27/2006 20:30	26.6	2.65
7/27/2006 20:45	26.57	2.59
7/27/2006 21:00	26.55	2.6
7/27/2006 21:15	26.54	2.53
7/27/2006 21:30	26.52	2.52
7/27/2006 21:45	26.51	2.36
7/27/2006 22:00	26.49	2.55
7/27/2006 22:15	26.47	2.53
7/27/2006 22:30	26.46	2.51
7/27/2006 22:45	26.44	2.49
7/27/2006 23:00	26.43	2.47
7/27/2006 23:15	26.41	2.44
7/27/2006 23:30	26.39	2.41
7/27/2006 23:45	26.37	2.41
7/28/2006 0:00	26.36	2.46
7/28/2006 0:15	26.34	2.41
7/28/2006 0:30	26.32	2.39
7/28/2006 0:45	26.31	2.42
7/28/2006 1:00	26.29	2.39
7/28/2006 1:15	26.27	2.37

7/28/2006 1:30	26.25	2.33	
7/28/2006 1:45	26.24	2.35	
7/28/2006 2:00	26.22	2.3	
7/28/2006 2:15	26.2	2.31	
7/28/2006 2:30	26.18	2.31	
7/28/2006 2:45	26.16	2.3	
7/28/2006 3:00	26.14	2.3	
7/28/2006 3:15	26.13	2.28	
7/28/2006 3:30	26.11	2.28	
7/28/2006 3:45	26.1	2.14	
7/28/2006 4:00	26.08	2.23	
7/28/2006 4:15	26.06	2.21	
7/28/2006 4:30	26.05	2.2	
7/28/2006 4:45	26.03	2.2	
7/28/2006 5:00	26.02	2.15	
7/28/2006 5:15	25.99	2.16	
7/28/2006 5:30	25.97	2.12	
7/28/2006 5:45	25.94	2.14	
7/28/2006 6:00	25.92	2.13	
7/28/2006 6:15	25.89	2.14	
7/28/2006 6:30	25.87	2.09	
7/28/2006 6:45	25.85	2.1	
7/28/2006 7:00	25.83	2.08	
7/28/2006 7:15	25.82	2.08	
7/28/2006 7:30	25.8	2.07	
7/28/2006 7:45	25.8	2.07	
7/28/2006 8:00	25.8	2.02	
7/28/2006 8:15	25.8	2.01	
7/28/2006 8:30	25.82	2.03	
7/28/2006 8:45	25.83	1.98	
7/28/2006 9:00	25.84	2.01	
7/28/2006 9:15	25.86	2.01	
7/28/2006 9:30	25.89	2.03	
7/28/2006 9:45	25.94	2.04	
7/28/2006 10:00	25.98	2.07	
7/28/2006 10:15	26.04	2.08	
7/28/2006 10:30	26.08	2.11	
7/28/2006 10:45	26.15	2.1	
7/28/2006 11:00	26.24	2.16	Retrieve 2.03
7/28/2006 11:15	27.4	6.94	Out of water
7/28/2006 11:30	30.4	7.21	Out of water
7/28/2006 11:45	32.07	7.29	Out of water
7/28/2006 12:00	33.1	7.29	Out of water
7/28/2006 12:15	35.29	7.17	Out of water
7/28/2006 12:30	36.64	6.87	Out of water
7/28/2006 12:45	37.49	6.69	Out of water
7/28/2006 13:00	26.72	3.38	Control 3.25